laid upon the importance of carefully marking stations; and the detailed instructions in regard to the subject occupy two quarto pages in the manual 'On the field-work of triangulation,' issued by the survey. The most common method used is the one which has been copied by the N. Y. state survey. Other methods, however, are used in special cases. For recovering a station, the main dependence is upon the surface-marks, and the underground-marks are used only for protection in case of the destruction of the others by accident or design.

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Washington, D. C.,
April 22, 1883.

Freezing of liquids in living vegetable tissue.

The conclusions of Mr. Meehan in relation to the above topic (SCIENCE, p. 229) seem to me scarcely warranted by the best authenticated facts in vegetable physiology. Experimental investigations and researches, undertaken many years ago, led me to the following deductions:[1] —

1. That the sap of many living plants can be frozen by the application of a degree of cold not much below that required to freeze it when removed from the plant; and that in very cold climates the sap of all perennial plants must be frozen in all parts during the winter months.

2. That the congelation of the juices of living vegetables does not, as many phytologists have imagined, necessarily and inevitably result in the death of the whole plant, or of the part in which it takes place, but, on the contrary, that frequently no injurious consequences follow. Consequently it is unwarrantable to assume that a plant which is not killed by severe cold never was frozen; and therefore it is unnecessary to invoke the aid of a 'vital power' to enable plants to survive the influence of cold sufficiently intense to freeze their juices when removed from the living plant.

3. That the bursting of the trunks of trees in high latitudes is not due to the expansion which the sap undergoes in process of congelation, but to the unequal contraction which takes place in the trunk (usually after the complete congelation of its juices) in consequence of a sudden depression of temperature. In short, that the rupture of the trunk in such cases is due to the same cause as the rents in the frozen ground, and the cracks in large sheets of thick ice, which occur in high latitudes when there is sudden accession of cold. This view is fortified by the fact that the coefficient of contraction (or expansion) of ice is greater than that of any other solid body hitherto examined, with the exception of hardened caoutchouc, or ebonite.

JOHN LECONTE.

Berkeley, Cal., April 17, 1883.

Sun's radiation and geological climate.

In his review of Whitney's climatic changes, Mr. Gilbert says, "His [Whitney's] hypothesis that the intensity of solar radiation is gradually lessening, by reason of the dissipation of solar energy, . . . will be admitted by most students." Mr. Whitney and his reviewer fall into the very natural error, that a loss of heat, and, of course, of energy, is *necessarily* accompanied by a fall in temperature. Paradoxical as it may appear, a loss of both heat and energy may produce a rise in the temperature of the body that loses them. If it be true that the sun is, as is now thought by many eminent scientists, a globe of gaseous matter, then, under the long process of giving off heat, it has actually been growing hotter, and the intensity of its heat on the earth's surface to-day is greater than it was in the early geological epochs.

The world is indebted for this curious fact to Mr. J. Homer Lane.[1] I quote from Newcomb's Astronomy, p. 508: "The principle in question may be readily shown in the following way: if a globular, gaseous mass is condensed to one-half its primitive diameter, the central attraction upon any part of its mass will be increased fourfold, while the surface upon which this attraction is exercised will be reduced to one-fourth. Hence the pressure per unit of surface will be increased sixteen times, while the density will be increased only eight times. Hence, if the elastic and gravitating forces were in equilibrium in the primitive condition of the mass, its temperature must be doubled in order that they may still be in equilibrium after the diameter is reduced one-half."

Admitting, then, the gaseous condition of the sun, as, under our present knowledge, we seem compelled to do, we must also admit that the intensity of the sun's radiation of heat has been slowly increasing through the ages, and to-day is greater than at any previous time. The increase may have been small; but, so far as there has been any change, it has been in the direction of an increase, and hence cannot explain the undoubted decrease in the general temperature of the earth's atmosphere indicated by the paleontological record.

C. B. WARRING.

Distribution of public documents.

Few outside of the ranks of professional politicians will disagree with the report of the committee of Congress on the printing and distribution of public documents, or with the tenor of the editorial remarks on the subject in No. 9 of SCIENCE. But it is to be feared that it will be as difficult to induce the average congressman to dispense with these lubricants of the political machine as with the senseless distribution, through the department of agriculture, of seeds that can as well be bought at any country store. If any means can be devised by which the 'costly and beautifully illustrated volumes' shall reach those for whose information they were written, instead of serving to adorn the nurseries of influential ward strikers and campaign committee men, it will redound greatly to the benefit of scientific knowledge and progress; for at present it is mainly through the medium of second-hand book-stands that those interested can occasionally get the professional works of which their political insignificance did not render them worthy recipients.

There is one notable exception, however, to this extravagance and misdirection of precious documents, the result of one of those spasms of virtue mentioned in the editorial. I refer to the law concerning the distribution of the publications of the geological survey, to which director Powell has called attention in a circular issued some time ago. According to the terms of this law, these documents, excepting the general report, can be obtained only by purchase or exchange; that is, the scientific workers of the country may at first get what may be deemed the equivalent of their own publications, or, possibly, of rare works in their possession. But when this resource is exhausted, the only method open to them, for obtaining what in many cases is the sequel of

[1] For the exposition of the basis of these deductions, the reader is referred to the memoir of the writer, entitled "Observations on the freezing of vegetables, and on the causes which enable some plants to endure the action of extreme cold."—(*Proc. Amer. assoc. adv. sc.*, vi. 338-359; *Amer. journ. sc.* [2], xiii. 84-92, 195-206.)

[1] See *Amer. journ. sc.*, July, 1870.